

1447-2554 (On-line)

<http://museumvictoria.com.au/about/books-and-journals/journals/memoirs-of-museum-victoria/>

The Psolidae of New Zealand and some additions to the Macquarie Ridge fauna (Echinodermata: Holothuroidea: Psolidae)

NICOLA DAVEY¹ (<http://zoobank.org/urn:lsid:zoobank.org:author:EEBE7A67-A2AB-4504-89D5-D70748AF7570>) and
EMILY WHITFIELD² (<http://zoobank.org/urn:lsid:zoobank.org:author:C665620D-DD0D-4F56-9557-32DF50CB80CC>)

¹ National Institute of Water and Atmosphere Research Ltd (NIWA), PO Box 893, Nelson 7040, New Zealand
(niki.davey@niwa.co.nz)

² Marine Biology Section, Museum Victoria, GPO Box 666, Melbourne 3001, Australia (whitfield.emily@gmail.com)

<http://zoobank.org/urn:lsid:zoobank.org:pub:131EFBFB-3A77-4C35-9FC0-4451DDAC4A0A>

Abstract

Davey, N. and Whitfield, E. 2013. The Psolidae of New Zealand and some additions to the Macquarie Ridge fauna (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 70: 51–67.

One new species of *Psolus* and four new species of *Psolidium* are described from New Zealand and Macquarie Ridge: *Psolus macquariensis* sp. nov., *Psolidium aequum* sp. nov., *Psolidium kermadeci* sp. nov., *Psolidium marriotti* sp. nov. and *Psolidium ramum* sp. nov. *Psolus neozelanicus* is a subjective junior synonym of *Psolus antarcticus*. New material is assigned to *Psolus squamatus* (Müller) var. *segregatus* Perrier and the diagnostic characters noted. *Psolidium whittakeri* O'Loughlin and Ahearn, formerly known only from Antarctic waters, also occurs off New Zealand. Ten species of the family Psolidae are now known from New Zealand: five in the genus *Psolus* Oken, and five in the genus *Psolidium* Ludwig. A key to the New Zealand and included Macquarie material is provided.

Keywords

Psolus, *Psolidium*, New Zealand, Macquarie Ridge, sea cucumber, Psolidae, new species, keys

Introduction

The most recent inventory of New Zealand Holothuroidea (Mah *et al.*, 2009) listed only three species in the family Psolidae Burmeister, 1837, and all were assigned to the genus *Psolus* Oken, 1815. One (*Psolus neozelanicus* Mortensen, 1925) was based on a single occurrence of a small specimen; another (*Psolus squamatus* (O.F. Müller, 1776)) was a known northern hemisphere species complex, and the third (*Psolus* ?n. sp.) remained unidentified. Examination of the considerable holdings of New Zealand's National Institute of Water and Atmosphere Ltd (NIWA) Invertebrate Collection (NIC) provided the opportunity to review the New Zealand psolid fauna. An overview of the Australian psolid holothuroids was recently published (Mackenzie and Whitfield, 2011); five new species were described and a comprehensive key to all 19 species now known in Australian and Macquarie waters was provided. This key was used as a basis for evaluation of the New Zealand psolid material and to assess the extent of overlap with the Australian fauna. Ten species in the genera *Psolus* and *Psolidium* were identified; five of them are described here, and for the remaining five species we provide new distribution records, comments on bathymetric and/or geographic range extensions, and diagnostic characters where required.

Of the six genera of the family Psolidae—*Ceto* Gistel, 1848, *Echinopsolus* Gutt, 1990, *Ekkentropelma* Pawson, 1971, *Lissothuria* Verrill, 1867, *Psolidium* Ludwig, 1886 and *Psolus*

Oken, 1815—only two genera currently occur in New Zealand waters.

We are aware of the current invalid status of *Psolus* Oken, 1815 and use the genus name provisionally as we await the outcome of a request for validation by the International Commission for Zoological Nomenclature (Paulay and O'Loughlin, pers. comm.).

Methods

In order to extract the ossicles, the body wall tissue was dissolved in liquid household bleach. The extracted ossicles were studied by light microscopy (Nikon YS2-H) and by scanning electron microscopy (Philips XL30S FEG SEM). Clean ossicles for SEM examination were spread on a glass disk, air-dried and coated with platinum for 10 min. Photographs and measurements of the ossicles were taken. Specimen pictures were taken with a Nikon DX camera with a 60 mm macro lens. All specimens, including holotypes and paratypes, are registered in the NIC in Wellington. The internal anatomy is not systematically diagnostic and is not included in the new species descriptions.

In the following species descriptions, the station details are in the following format: the catalogue number NIWA XXXXX (number of specimens), voyage abbreviation and station number, latitude and longitude, depth, date of collection.

Abbreviations

CSIRO	Commonwealth Scientific and Industrial Research Organisation.
FRST	New Zealand Foundation for Research, Science and Technology.
KARMA	Kermadec Arc Minerals.
LINZ	Land Information New Zealand.
MBIE	New Zealand Ministry of Business, Innovation and Employment.
MPI	Ministry for Primary Industries (previously the New Zealand Ministry of Fisheries).
MV	Museum Victoria.
NIWA	National Institute of Water and Atmospheric Research Ltd, Wellington, New Zealand.
RV <i>Sonne</i>	Vessel used by IFM-GEOMAR Leibniz-Institut für Meereswissenschaften an der Universität Kiel and partners, and the interdisciplinary New Zealand–Australian ‘MacRidge 2’ research voyage.
RV <i>Tangaroa</i>	NIWA’s research vessel.
SEM	Scanning electron microscopy.
TANXXXX/xx	RV <i>Tangaroa</i> research voyages (undertaken by NIWA) followed by year of the voyage, trip number and station number.
USNM	Smithsonian Institution National Museum of Natural History, Washington, DC, USA.

Key to New Zealand and Macquarie Ridge species of Psolidae Burmeister, 1837

- 1 Tube feet project through dorsal and lateral scales: *Psolidium* Ludwig, 1886 **6**
 - Tube feet absent dorsally: *Psolus* Oken, 1815 **2**
- 2 Five symmetrical oral valves **3**
 - Not with 5 symmetrical oral valves **4**
- 3 No encroachment of scales onto oral valves, no bowl ossicles ventrally *Psolus antarcticus* (Philippi, 1857)
 - Some encroaching of scales onto oral valves, bowl ossicles present ventrally *Psolus parantarcticus* Mackenzie and Whitfield, 2011
- 4 More than 5 irregular oral valves. Conspicuous demarcation between dorsal scales and oral and anal valves. Macroscopic dome-like lumps on dorsal and lateral surface. Oral and anal opening conspicuous. Body wall does not contain cups **5**
 - No distinct oral valves. No demarcation between dorsal scales and oral and anal valves. No macroscopic dome-like lumps on dorsal surface. Oral and anal opening inconspicuous. Body wall contains cups *Psolus macquariensis* sp. nov.
- 5 Profile low, smooth, domed. Anterior and anal openings not raised. Half-cylinders present in dorsal ossicles *Psolus salottii* Mackenzie and Whitfield, 2011
 - Profile not low, smooth, domed. Anterior and anal openings raised. No half-cylinders present in dorsal ossicles *Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905
- 6 Dorsal and lateral tube feet conspicuous macroscopically. Ventral ossicles thin-walled plates with 3–4 perforations, up to 125 µm long, 40 µm wide *Psolidium kermadeci* sp. nov.
 - Dorsal and lateral tube feet inconspicuous macroscopically. Ventral ossicles thick-walled plates **7**
- 7 Midventral row of tube feet. Dorsal and ventral ossicles contain branching rods (thorns) *Psolidium ramum* sp. nov.
 - No midventral row of tube feet. Dorsal and ventral ossicles do not contain branching rods (thorns) **8**
- 8 Less than 8 dorsal scales between oral and anal openings. Dorsal body wall appears rough. Largest specimen 16 mm total length. Tentacle trunk ossicles long, thick rods, sometimes perforated at ends or middle **9**
 - More than 8 dorsal scales between oral and anal openings. Smooth appearance dorsally. Specimens often greater than 16 mm total length. Largest tentacle trunk ossicles predominantly plates with large irregular perforations *Psolidium whittakeri* O’Loughlin and Ahearn, 2008
- 9 Ventral ossicles flat to slightly curved, single-layered, knobbed perforated plates with predominantly 4 (sometimes more) uniform perforations *Psolidium aequum* sp. nov.
 - Ventral ossicles flat to slightly curved, single-layered, knobbed perforated plates with 2 large central perforations and numerous smaller marginal perforations *Psolidium marriotti* sp. nov.

Order **Dendrochirotida** Grube, 1840 (restricted Pawson and Fell, 1965)

Family Psolidae Burmeister, 1837

Diagnosis. (See O’Loughlin and Maric, 2008). Body flattened, with well-defined ventral sole. Dorsal surface invested by imbricating scales. Ventral sole soft, surrounded by tube feet. Mouth and anus dorsally upturned.

Remarks. For synonymies, discussion, and a key to genera of Psolidae see O’Loughlin and Maric (2008) together with the amendments listed in O’Loughlin and Whitfield (2010) and Mackenzie and Whitfield (2011). There is a key to the Australian species of Psolidae in Mackenzie and Whitfield (2011), reflected in the key provided here.

Type genus. *Psolus* Oken, 1815 (original description; *Lepidopsolus* Bronn, 1860, and *Lophothuria* Verrill, 1867; synonymy by Théel, 1886).

Genus *Psolus* Oken, 1815

Diagnosis. (O'Loughlin and Whitfield 2010). Psolidae with large imbricating or contiguous dorsal and lateral scales; ventrolateral scales at margin clearly demarcated from thin sole that lacks conspicuous scales. Tube feet absent dorsally and laterally, sometimes present orally and anally.

Psolus antarcticus (Philippi, 1857)

Table 1, Figures 1, 3A–C

Holothuria antarctica Philippi, 1857: 133.

Psolus antarcticus Ludwig, 1898: 53, pl. 3-figs 34–36 (complete synonymy).—Ekman, 1923: 42, figs 31–33; 1925: 139, text-fig. 34.—Deichmann, 1947: 339.—Pawson, 1968a: 19, fig. 2 (1–4).—Mackenzie and Whitfield, 2011: 26–28.

Psolus neozelanicus Mortensen, 1925: 362, figs 44–45.—Dawbin, 1950: 35, pl. 1-fig. 2.—Pawson, 1970: 28.—Mah *et al.*, 2009: 398.—Mackenzie and Whitfield, 2011: 28.

Material examined. Macquarie Ridge: NIWA 40954 (2) Stn TAN0803/93, 56.25°S 158.51°E, 676–750 m, 16/04/2008; NIWA 40887 (16) Stn TAN0803/94, 55.37°S 158.38°E, 501–577 m, 15/04/2008; NIWA 40758 (9) Stn TAN0803/91, 55.36°S 158.42°E, 501–630 m, 15/04/2008; NIWA 40824 (1) Stn TAN0803/93, 55.35°S 158.43°E, 605–709 m, 15/04/2008; NIWA 40853 (1) Stn TAN0803/94, 55.37°S 158.38°E, 501–577 m, 15/04/2008; NIWA 68127 (1) Stn E227, 54.68°S 158.91°E, 148 m, 24/02/1965; NIWA 76248 (1) Stn C734, 53.91°S 158.91°E, 360 m, 25/11/1961. New Zealand, Hikurangi Margin: NIWA 65685 (8) Stn F767, 41.51°S 176.11°E, 1205 m, 21/08/1966; NIWA 63356 (1) Stn TAN1004/36, 41.59°S 175.85°E,

1150–1177 m, 18/04/2010; NIWA 63906 (9) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010; NIWA 71936 (19) Stn G954, 42.61°S 175.97°E, 1190 m, 02/06/1973. New Zealand, Chatham Rise: NIWA 30627 (2) Stn TAN0705/94, 44.56°S 178.4°E, 1110–1119 m, 10/04/2007; NIWA 30629 (1) Stn TAN0705/98, 44.56°S 178.4°W, 1074–1081 m, 10/04/2007; NIWA 30630 (8) Stn TAN0705/98, 44.56°S 178.4°W, 1074–1081 m, 10/04/2007; NIWA 63968 (2) Stn Z10820, 41.59°S 175.77°E, 1400 m, 26/05/2001; NIWA 63931 (1) Stn TAN1004/103, 42.13°S 174.53°E, 1169–1213 m, 25/04/2010; NIWA 71146 (1) Stn 2253/20, 44.7°S 176.6°E, 794–1156 m, 29/05/2006; NIWA 76355 (1) Stn S1065H, 44.14°S 178.5°E, 990 m, 05/05/1997.

Description. See Mackenzie and Whitfield (2011) for the most recent description of this species including photos of the ossicles. All material examined here concurs with this recent description and any variations or amendments are discussed below.

Colour. Preserved: white and pale brown; dorsal and lateral scales have pale brown centres with a white periphery. This differs from Mackenzie and Whitfield (2011), in which specimens examined were white only.

Distribution. Previously reported from South America (Magellanic region), South Georgia, Macquarie Island, 100–1666 m; extended here to New Zealand and further locations along Macquarie Ridge, 360–1480 m.

Remarks. Mackenzie and Whitfield (2011) recently confirmed the distribution of *Psolus antarcticus* (Philippi, 1857) as extending into Australian and Macquarie Island waters. Herein, we confirm that *P. antarcticus* is known from the continental

Table 1. Distribution of New Zealand and Macquarie Ridge species of Psolidae Burmeister, 1837.

Species	Distribution (new records are provided in bold)	Depth range (new records are provided in bold)
<i>Psolus</i> species		
<i>Psolus antarcticus</i> (Philippi, 1857)	Magellanic region of South America; South Georgia; Macquarie Island; New Zealand; Macquarie Ridge	100–1666 m
<i>Psolus macquariensis</i> sp. nov.	Macquarie Ridge	398–489 m
<i>Psolus parantarcticus</i> Mackenzie and Whitfield, 2011	Australia, Macquarie Island; New Zealand, Hikurangi Margin; Macquarie Ridge	108–135 m 104–1053 m
<i>Psolus salottii</i> Mackenzie and Whitfield, 2011	South Australia; Macquarie Ridge	400–820 m
<i>Psolus squamatus</i> (Müller, 1776) var. <i>segregatus</i> Perrier, 1905	South America, Straits of Magellan and Argentina; New Zealand, Hikurangi Margin, Chatham Rise	320–468 m, 817 m
<i>Psolidium</i> species		
<i>Psolidium aequum</i> sp. nov.	New Zealand, Hikurangi Margin	1040–1059 m
<i>Psolidium kermadeci</i> sp. nov.	New Zealand, Kermadec Trench	1380–1545 m
<i>Psolidium marriotti</i> sp. nov.	New Zealand, Hikurangi Margin, Chatham Rise, North Cape; Macquarie Ridge	136–885 m
<i>Psolidium ramum</i> sp. nov.	New Zealand, North Island west coast canyons	188–210 m
<i>Psolidium whittakeri</i> O'Loughlin and Ahearn, 2008	Antarctica; South Sandwich Island; South Shetland Island; Bouvet Island; New Zealand	146–759 m, 443–503 m

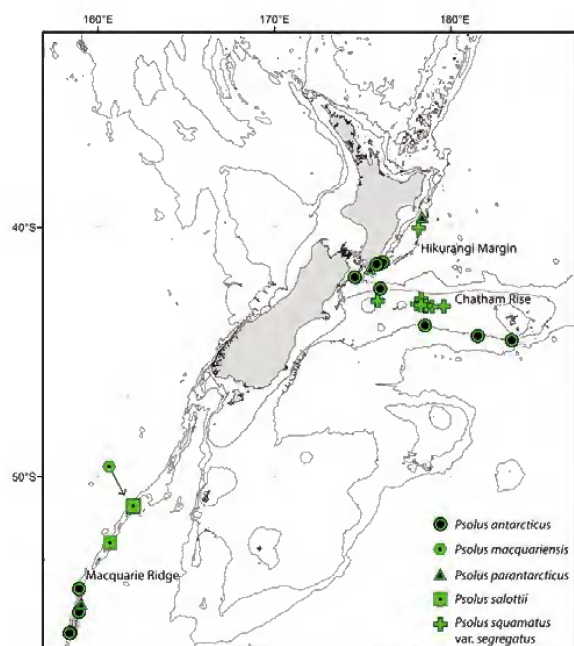


Figure 1. Map of area showing station locations of *Psolus* species in the New Zealand and Macquarie Ridge regions.

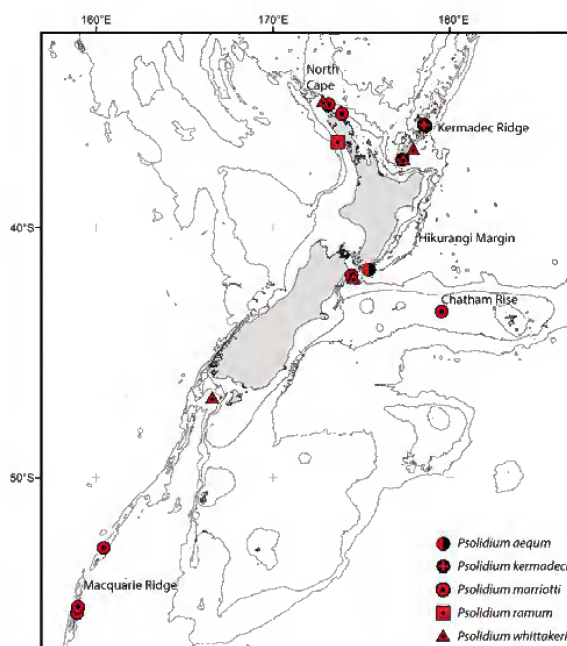


Figure 2. Map of area showing station locations of *Psolidium* species in the New Zealand and Macquarie Ridge regions.

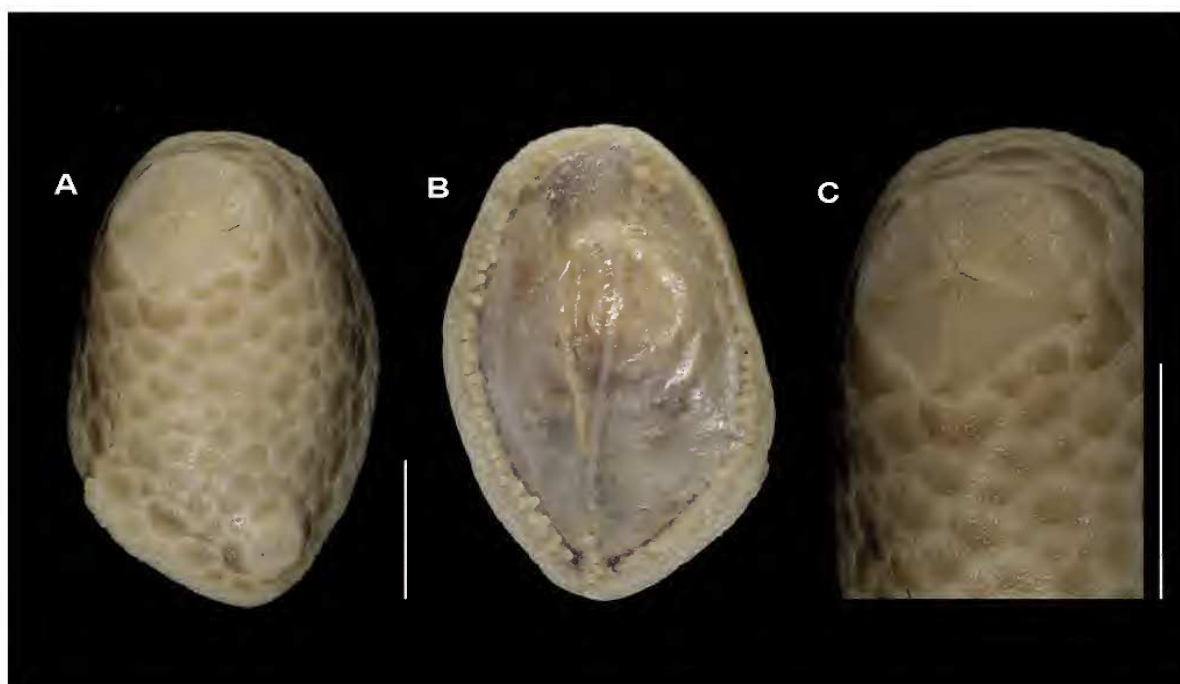


Figure 3. *Psolus antarcticus* (Philippi, 1857) (A–C, NIWA 30627): A, dorsal view; B, ventral view; C, close up of 5 even oral valves with no scale encroachment. Scale bar 1 cm.

slope around New Zealand, including the Chatham Rise. The specimens examined here morphologically match the type description, however, we do note that the colour of this relatively fresh material has brown scale centres compared with the uniform white colour previously reported. The depth distribution of the New Zealand material is within the known range of 100–1666 m.

Psolus neozelanicus Mortensen, 1925 was based on two small specimens from east of North Cape, New Zealand. It has not been collected since. This species was briefly discussed in Mackenzie and Whitfield (2011). We further judge from the type description of its knobbed perforated plates (four central perforations recognisable) and five symmetrical valves that this species is a subjective junior synonym of *Psolus antarcticus*. Mortensen (1925) discusses the ventral ossicles with four central perforations, which are well known in *P. antarcticus*. His illustrations (p. 363), however, tend to show ossicles with slightly more numerous perforations that are present dorsally, rather than ventrally. We re-examined some of our smaller (7–9 mm) *P. antarcticus* specimens (NIWA 40758) and found the ventral ossicles predominantly with four, but sometimes with up to six perforations like the larger *P. antarcticus*. Ventral ossicles were sparse in both of our small specimens. All specimens previously identified as *P. neozelanicus* in both the NIC and Museum of Victoria (MV) have been re-examined and determined to be *P. antarcticus* or *P. parantarcticus* Mackenzie and Whitfield, 2011.

Psolus macquariensis sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:B0AC4334-A7DF-4548-B5DB-D33715DB5A09>

Table 1, Figures 1, 4A–C, 7A–F

Material examined. Holotype. Macquarie Ridge: NIWA 40314 (1) Stn TAN0803/69, 52.39°S 160.65°E, 438–451 m, 09/04/2008.

Paratypes. NIWA 68135 (2) same locality data as holotype.

Other material. Macquarie Ridge: NIWA 40050 (1) Stn TAN0803/53, 51.04°S 162.01°E, 398–489 m, 05/04/2008; NIWA 40326 (2) Stn TAN0803/69, 52.39°S 160.65°E, 438–451 m, 09/04/2008.

Description. *Psolus* species up to 16 mm long, 6 mm high, 5 mm wide. Body form oval, low profile, body wall thin and soft. Oral and anal openings inconspicuous with no distinctive valves.

Dorsal and lateral scales inconspicuous, glassy bead-like texture, up to 800 μ m diameter, decreasing in size towards lateral edge. Sole elongate oval, thin walled, slight anterior taper. Tube feet on sole periphery in 2 rows; inner series close together, continuous, terminal disc up to 400 μ m diameter; outer series smaller, terminal disc up to 250 μ m diameter, sparsely arranged, not complete. Midventral single row of scattered tube feet, which can be long with terminal discs on ends of extended stalks, some extending over the sole margin.

Dorsal and lateral ossicles single-layered perforated plates (scales), some with secondary thickening and ribbing towards centre of plates, up to 810 μ m wide; cups up to 45 μ m long, 30 μ m deep with a cross-type base, knobbed edges. Ventral ossicles single-layered, smooth perforated plates up to 150 μ m

long, sparse cups up to 65 μ m long. Tentacle ossicles single-layered perforated plates only, up to 230 μ m long.

Colour. Preserved: white.

Distribution. Macquarie Ridge, 398–489 m.

Etymology. Named after the type locality, Macquarie Island.

Remarks. *Psolus macquariensis* sp. nov. is closest to southern Australian species *Psolus steuarti* Mackenzie and Whitfield, 2011, with its similar granulated scales dorsally and laterally, and cups in the dorsal body wall. *P. macquariensis* sp. nov. differs from *P. steuarti* in the presence of midventral tube feet and in the dorsal and lateral ossicles consisting of only single-layered plates. Also, in *P. macquariensis* sp. nov., ventral ossicles are smooth perforated plates, while *P. steuarti* has knobbed plates.

Psolus parantarcticus Mackenzie and Whitfield, 2011

Table 1, Figure 1

Material examined. New Zealand, Hikurangi Margin: NIWA 68125 (1) Stn TAN0616/83, 41.78°S 175.39°E, 1053–1050 m, 13/11/2006; NIWA 68128 (1) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006. Macquarie Ridge, NIWA 76249 (1) Stn C733, 54.41°S 159.03°E, 104 m, 25/11/1961.

Description. See Mackenzie and Whitfield (2011). All specimens examined concur with this description unless discussed below.

Colour. Preserved: white (Mackenzie and Whitfield, 2011), although in present material dorsal and lateral scales have some pale brown markings.

Distribution. Australia, Macquarie Island, 108–135 m (Mackenzie and Whitfield, 2011). New Zealand and Macquarie Ridge, 1052 m (this study).

Remarks. *Psolus parantarcticus* Mackenzie and Whitfield 2011 was first described from Macquarie Island. We subsequently found two more specimens of this species in our New Zealand and Macquarie Ridge material. The encroaching valves, ventral bowl-shaped ossicles, and multilayered dorsolateral ossicles are distinctive morphological features that clearly differentiate this species from *P. antarcticus*. This study significantly extends the known depth range for *P. parantarcticus* from 135 to 1052 m.

Psolus salottii Mackenzie and Whitfield, 2011

Table 1, Figure 1

Material examined. Macquarie Ridge: NIWA 39894 (1) Stn TAN0803/48, 51.09°S 161.97°E, 462–524 m, 04/04/2008; NIWA 39928 (2) Stn TAN0803/48, 51.09°S 161.97°E, 462–524 m, 04/04/2008; NIWA 39979 (3) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 39993 (4) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 40010 (3) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 40047 (1) Stn TAN0803/53, 51.04°S 162.01°E, 398–489 m, 05/04/2008; NIWA 40355 (18) Stn TAN0803/71, 52.34°S 160.68°E, 488–542 m, 09/04/2008; NIWA 40396 (14) Stn TAN0803/71, 52.34°S 160.68°E, 488–542 m, 09/04/2008.

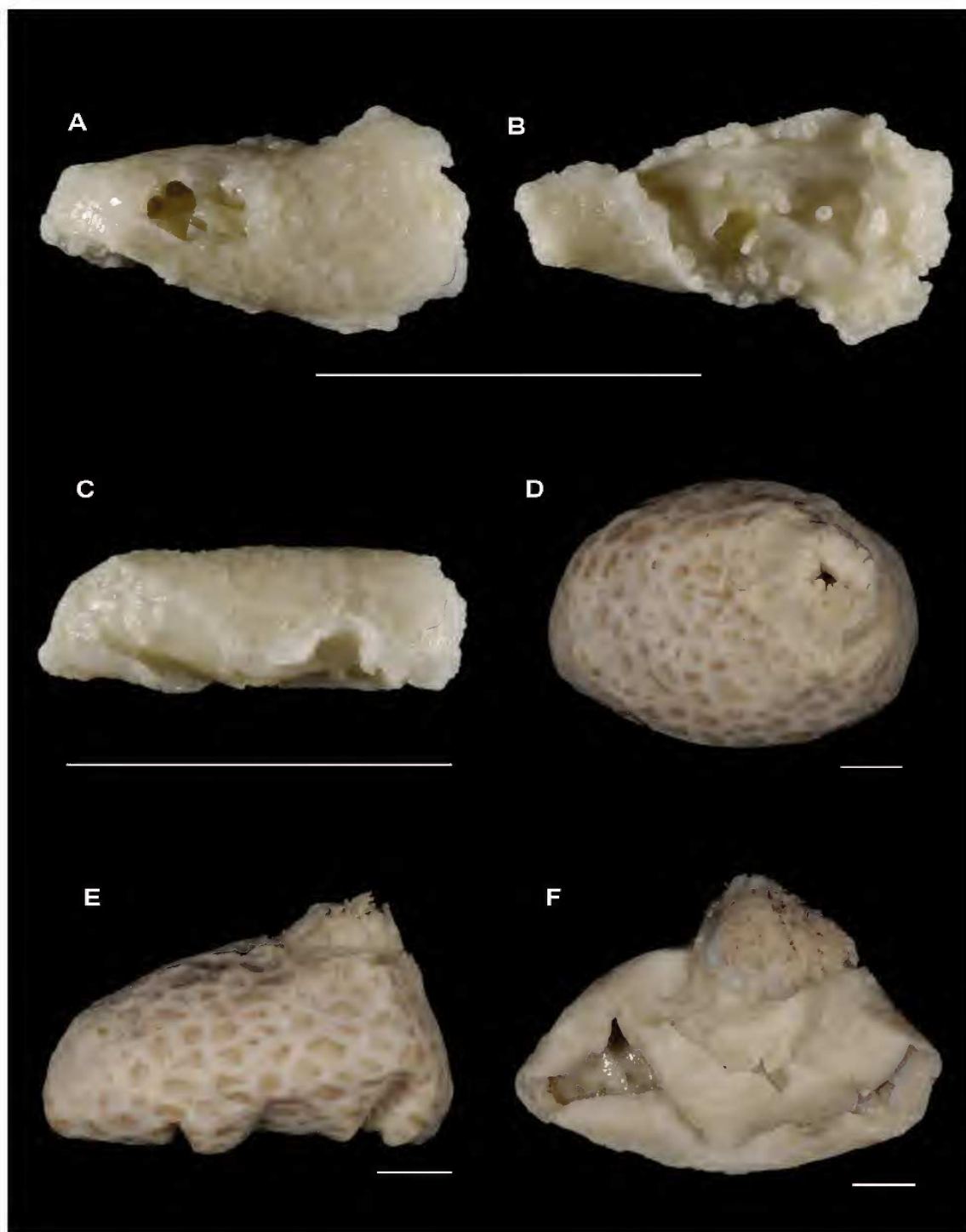


Figure 4. *Psolus macquariensis* sp. nov. paratype (A–C, NIWA 40314): A, dorsal view; B, ventral view showing some extended tube feet; C, lateral view. *Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905 (D–E, NIWA 43709): D, dorsal view; E, lateral view. *Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905 (F, NIWA 43714): lateral view of specimen with numerous sole ossicles. Scale bar 1 cm.

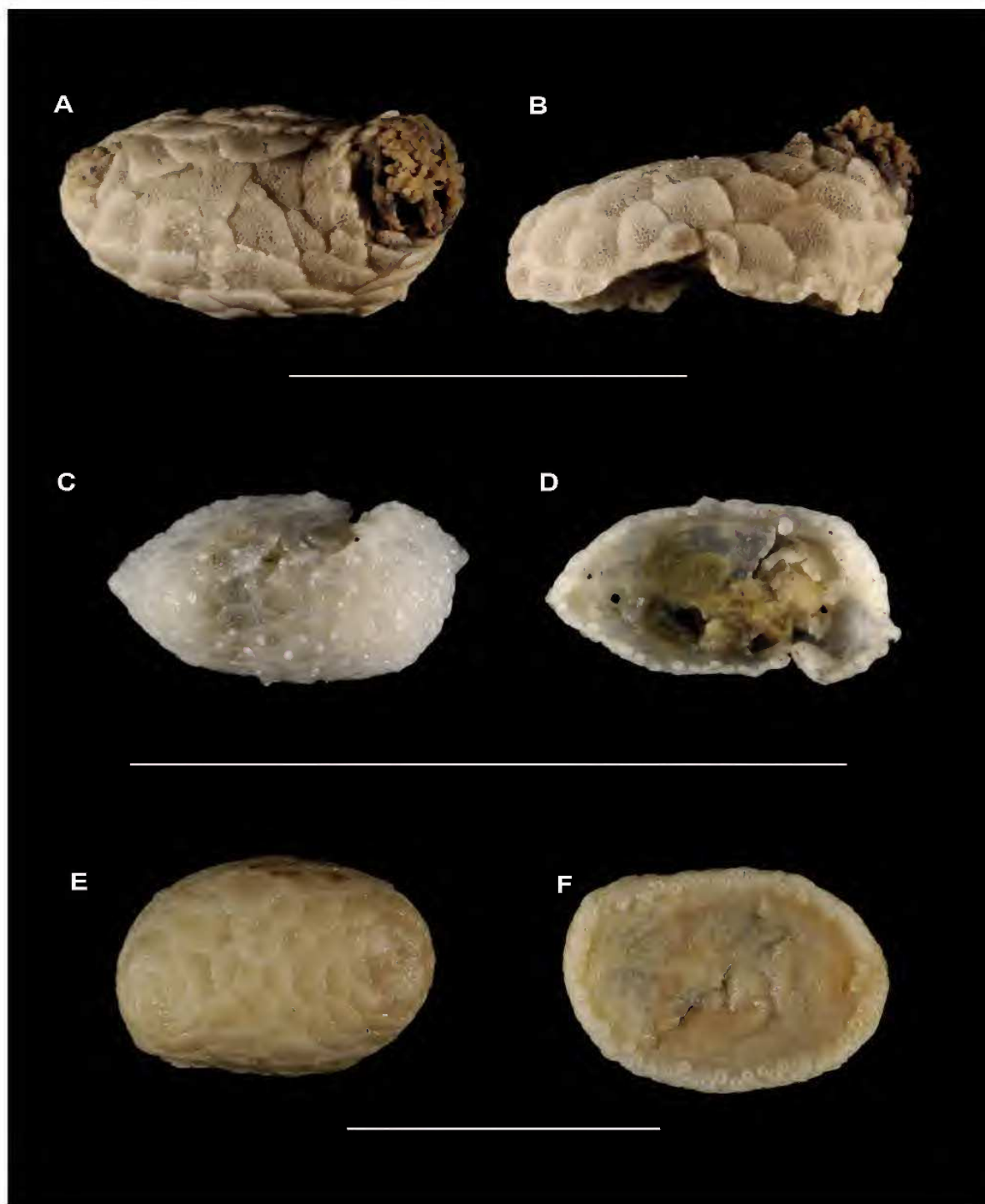


Figure 5. *Psolidium aequum* sp. nov. (A–B, NIWA 32259): A, dorsal view; B, lateral view. *Psolidium kermadeci* sp. nov. paratype (C–D, NIWA 64441): C, dorsal view showing conspicuous tube feet; D, ventral view. *Psolidium marriotti* sp. nov. paratype (E–F, NIWA 76126): E, dorsal view; F, ventral view. Scale bar 1 cm.

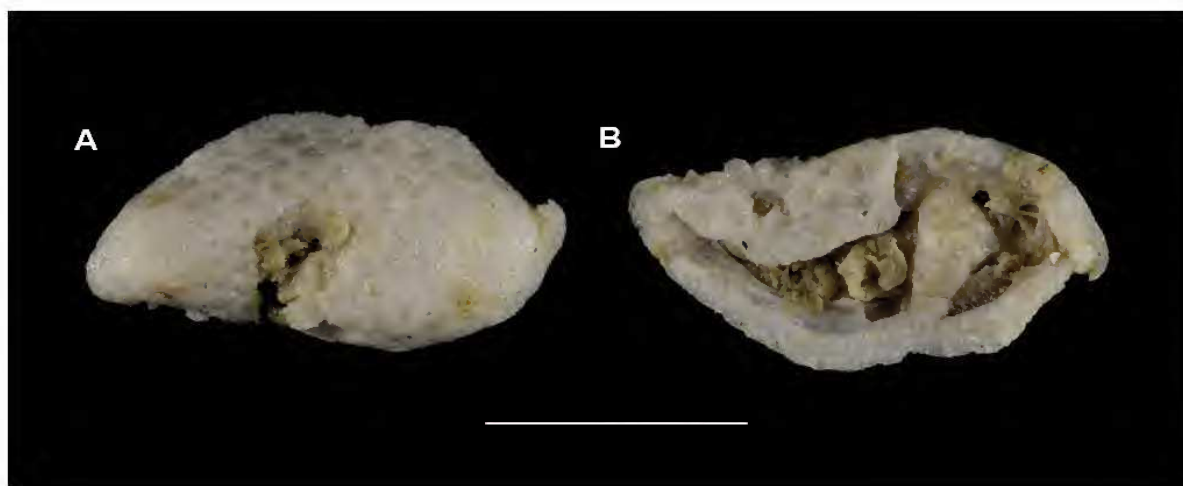


Figure 6. *Psolidium ramum* sp. nov. holotype (A–B, NIWA 73660): A, dorsal view; B, ventral view. Scale bar 1 cm.

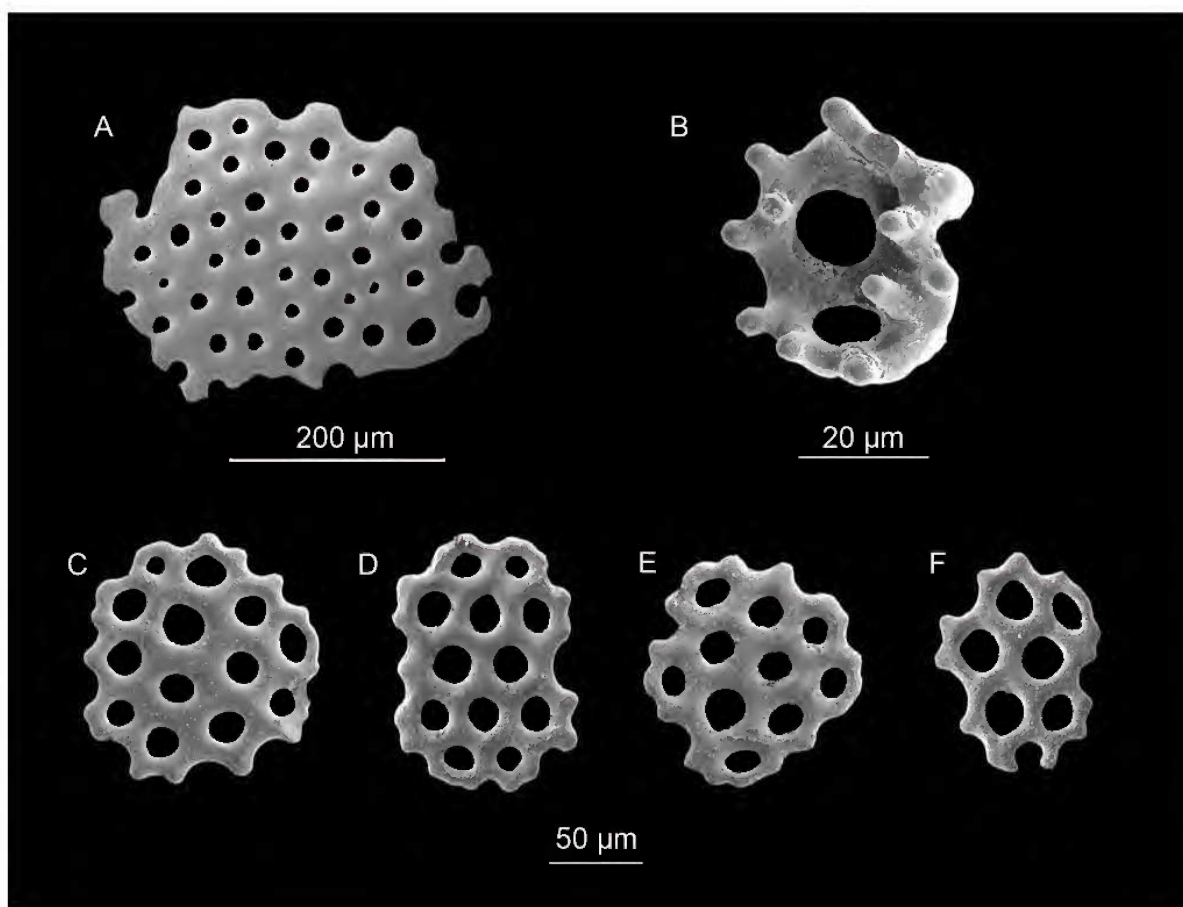


Figure 7. *Psolus macquariensis* sp. nov. paratype (A–F, NIWA 40314): A–B, dorsal single-layered plate, dorsal cup; C–F, ventral ossicles, smooth perforated plates.

Description. See Whitfield and Mackenzie (2011). The material examined matches the description well, and we make the following additions: *Psolus salottii* Whitfield and Mackenzie, 2011, up to 71 mm length (NIWA 40355), 54 mm wide, 29 mm high. Oral valves large and inconsistent in shape, ranging from rectangular with blunt ends to approximately triangular with pointed tips. Valves usually 10; always greater than 5.

Colour. Preserved: white.

Distribution. South Australia, Macquarie Ridge (Whitfield and Mackenzie, 2011) and this paper, 400–600 m.

Remarks. The original description was based on one holotype specimen from southern Australia and four paratypes from Macquarie Island. We found an additional 46 specimens, confirming and extending the Whitfield and Mackenzie (2011) description. The dome-like lumps on the dorsolateral scales are not always visible, and they may only be on a few scales. The multilayered ossicles in the preparation are always distinctly dome-like and provide a useful diagnostic character for this species.

***Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905**

Table 1, Figure 1, 4D–F

Psolus squamatus, Düben and Koren, 1846 (var. ?).—Théel, 1886: 89–90, pl. 15-figs 1–2, pl. 6-fig. 2.

Psolus antarcticus.—Ludwig, 1894: 98 (in note) (part).

Psolus pauper Ludwig, 1894. (Synonymy in Deichmann, 1941.)

Psolus squamatus.—H.L. Clark, 1901: 165; 1901: 491. (Synonymy in Deichmann, 1941; non-*Psolus squamatus* (O.F. Müller, 1776).)

Psolus squamatus var. *segregatus* Perrier, 1905: 59–65.

Psolus segregatus.—Vaney, 1906: 26–30, pl. 1-figs 14–15, pl. 2-figs 19–20.

Psolus squamatus (O.F. Müller, Koren) var. *segregatus* Perrier, 1905.—Ekman, 1923: 1–59, 37 text-figs.—Ekman, 1925: 136–139, fig. 33.

Psolus squamatus (Koren) var. *segregatus* Perrier.—Deichmann, 1941: 147–148, pl. 30-fig. 7.

Psolus squamatus (Koren, 1845).—Pawson, 1969: 129 (not *Psolus squamatus* (O.F. Müller, 1776)).

Psolus aff. *squamatus* (O.F. Müller, 1776).—Massin and Hendrickx, 2011: 419–420.

Material examined. New Zealand, Chatham Rise: NIWA 27619 (2) Stn TAN0701/14, 43.35°S 179.58°E, 409–423 m, 31/12/2006; NIWA 43709 (1) Stn TAN0801/4, 43.26°S 178.05°E, 320–339 m, 28/12/2007; NIWA 43714 (1) Stn TAN0801/37, 44.22°S 179.1°E, 484–492 m, 03/01/2008; NIWA 44805 (5) Stn TAN0501/90, 43.36°S 178.53°E, 371–384 m, 14/01/2005; NIWA 49919 (1) Stn TAN0301/64, 43.92°S 179.7°W, 405–420 m, 10/01/2003; NIWA 76127 (8) Stn TAN0201/20, 43.28°S 178.27°E, 348–358 m, 01/01/1999; NIWA 76128 (6) Stn Z10972, 43.12°S 175.81°E, 467 m, 04/09/2001; NIWA 76129 (4) Stn Z10931, 43.13°S 175.83°E, 441 m, 30/10/2001; NIWA 76130 (4) Stn Z10929, 43.12°S 175.81°E, 467 m, 4/09/2001; NIWA 76131 (27) Stn Z9618, 43.36°S 178.91°E, 393 m, 04/01/1999; NIWA 76132 (6) Stn Z10829, 43.26°S 178.42°E, 374 m, 30/12/2000; NIWA 76133 (2) Stn Z10585, 43.05°S 178.29°E, 341 m, 30/12/2000; NIWA 76134 (1) Stn Z10583, 43.32°S 178.56°E, 398.0 m, 12/01/2001; NIWA 76424 (2) Stn TAN0601/10, 43.31°S 178.26°E, 324–340 m, 29/12/2005.

Description. Follows Perrier (1905) and Ekman (1923) with additional details based on the specimens examined. *Psolus* species up to 61 mm long, 30 mm high, 39 mm wide. Body

form oval, mid- to high-domed profile with raised oral and anal valves, higher anteriorly. Oral opening surrounded by 7–12 long, irregular, triangular to oblong oral plates or plate fragments, inconsistent in shape and number, imbricating slightly, thickly calcareous, granular surface, demarcation between body scales and oral plates variable, usually some body scales encroaching at base of oral plates. Anal opening a series of small scales continuous with dorsal and lateral scales, no distinct plates, heavily imbricating in circular formation surrounding the anus.

Dorsal and lateral scales predominantly 3–5 mm wide, a few up to 12 mm wide, but decreasing in size towards anal and oral valves and at lateral edge, macroscopically evident, scales imbricate slightly; scale margin colouration consistently light (white or cream), usually with a brown centre, variable in intensity, can appear spotty; scales with coarsely granular surface, granules loose or attached, globular, up to 310 μ m wide. Sole oval, without tapering anally or orally; inner series of tube feet arranged in 1–3 rows around the outer sole perimeter, crowded, can extend midventrally posteriorly and anteriorly; outer peripheral series of smaller tube feet in a spaced, single row, close to the ventral margin; midventral series of tube feet variably present, extending anteriorly or posteriorly only, or absent completely.

Dorsal and lateral ossicles mainly large multilayered plates covered in granules, as described above; some thickened plates up to 180 μ m long; rare smooth perforated plates up to 130 μ m long; rare single-layered plates with secondary layering in some specimens. Ventral ossicles perforated plates ranging from simple crosses without complete perforations to some with up to 15 perforations.

Colour. Preserved. Directly into ethanol: oral, anal valves and sole white; dorsal scales centrally graduating brown to cream, white on perimeter. Frozen then ethanol: cream scales, white plates, no brown centres (NIWA 43714, NIWA 44805).

Distribution. South America, Strait of Magellan and Argentina, 256–274 m. Extended to New Zealand, Chatham Rise, 320–492 m here.

Remarks. The majority of the New Zealand material fits the description above, but there is variability in the number and appearance of the ventral ossicles. The variability ranges from a complete absence of ossicles (majority of specimens) to specimens with rare broken pieces of single-layered, smooth perforated plates (0–3 perforations, NIWA 76130, NIWA 76127, NIWA 76128) and two specimens (NIWA 43714, NIWA 44805) yielding smooth perforated plates and rare broken pieces. These plates variably have marginal projections, low knobs, and can be flat to slightly concave.

Théel (1886), Ludwig (1894), Perrier (1905) and Vaney (1906) all tried but failed to find a diagnostic difference between the North Atlantic and southern American specimens of *Psolus squamatus* (O.F. Müller, 1776), but the opinion was shared that a bipolar species was unlikely, and accordingly Perrier (1905) erected the variety *segregatus* for the southern form. Ekman (1923) presented an exhaustive comparison of Norwegian and South American specimens and confirmed the status of the variety *Psolus squamatus* (Müller, 1776) var.

segregatus Perrier, 1905. In particular Ekman (1923) recognised the significant size difference in the dorsal and lateral surface granules. Deichmann (1941) and Massin and Hendrickx (2011) accepted the status of the variety. Pawson (1969) determined specimens from Chile to be *P. squamatus* and did not accept the distinct species or variety status.

O'Loughlin (pers. comm.) examined specimens in the Smithsonian Institution that were identified as *Psolus squamatus* (Müller, 1776), from Norway (USNM 8583), the West European Basin (USNM E38321), and Alaska (USNM 24536, USNM E27846). He concluded that there are two species represented and neither is conspecific with the Californian specimens (USNM E17011, USNM E16931), which are in turn not conspecific with southern American specimens from the Strait of Magellan (USNM E33632, USNM E33634, USNM E33635) and Argentina (USNM 22201). A useful character for distinguishing between the different putative species in this complex may be the presence or absence and size of surface granules. The species most similar to *P. squamatus* that range in their distribution from the North Atlantic and into the Pacific along the western coast of the Americas from Alaska to Cape Horn are united by the presence of larger surface granules. Overall, the dorsal surface loose granule size, and the sole ossicle perforations and sizes are the major differences between *P. squamatus* and *P. squamatus* var. *segregatus*. *Psolus squamatus* var. *segregatus* sole ossicles are perforated plates that are smaller (75–110 µm) compared with those of *P. squamatus* (150–300 µm).

The status of both the species and the variety is undergoing an extensive systematic review (Martinez, pers. comm.). Until this is complete, our New Zealand species is designated as *P. squamatus* var. *segregatus*, but with minor reservation. The largest ossicles we found (in only two specimens) ranged from 95–140 µm long, but never reached the size documented for *Psolus squamatus*. Also, the size of the dorsal granules for *P. squamatus* var. *segregatus* is documented at 330–470 µm compared with 150–250 µm in *P. squamatus*. Our New Zealand specimen's dorsal granules were variable in size, but the loose ones were measured as predominantly 270–350 µm, with only a few larger ones variably present (up to 500 µm). Our minor reservation is the frequent absence of ossicles in the sole in our New Zealand specimens. Deichmann (1941), when discussing the variety, notes that the ossicles often disappear with age. Ossicles were predominantly absent in large specimens, hence our decision to place these New Zealand specimens in *P. squamatus* var. *segregatus*. All these examined specimens come from similar locations and depths and are of comparable sizes.

Genus *Psolidium* Ludwig, 1886

Diagnosis. (After O'Loughlin and Maric, 2008). Dendrochirotid holothuroids; small, up to 40 mm long; midbody arched dorsally in transverse section, flat ventrally; dorsal and lateral body covered with imbricating scales, usually macroscopically conspicuous, sometimes obscured by integument, scales irregular in size and arrangement; scales decreasing in size ventrolaterally, orally and anally; lacking large oral valves;

extensible oral cone with anterior, anterior–dorsal or dorsal orientation; extensible anal cone with posterior, posterior–dorsal or dorsal orientation; tube feet dorsally and laterally in midbody, passing through scales.

Sole distinct, oval to elongate; discrete margin created by junction of small imbricating ventrolateral scales, with thin-walled, usually calcareous sole that lacks scales; peripheral band of tube feet, may be discontinuous across the interradii anteriorly and posteriorly; peripheral tube feet frequently of 2 sizes, those of outer series smaller; midventral radial series of tube feet present or absent.

Calcareous ring solid, plates subrectangular, radial and interradii plates with tapered anterior projections; radial plates with deep notch posteriorly, interradii plates with shallow concave indentation posteriorly; 10 dendritic tentacles, ventral 2 smaller.

Dorsal and lateral ossicles: multilayered or single-layered perforated plates (scales), always some with tube foot canals; integument covering scales may have cupped crosses, cups, 'thorn' ossicles (irregular branched rods pointed distally), buttons, perforated plates and rosettes; tube foot small endplates, and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Sole ossicles: interradii with small to large single-layered perforated plates (rarely with multilayering), smooth to variably knobbed and thickened, sometimes with cupped crosses, cups, thorn ossicles and rosettes; radii with additional tube foot ossicles, large endplates and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Psolidium aequum sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:3EC47623-6ED4-442B-887C-C4454A26A2A1>

Table 1, Figures 2, 5A–B, 8A–H.

Material examined. Holotype, New Zealand, Hikurangi Margin: NIWA 68136 (1) Stn SO191-2/138, 41.78°S 175.40°E, 1043–1059 m, RV *Sonne*, 18/02/2007.

Paratypes, NIWA 32023 (29), same as holotype locality and date.

Other material. Hikurangi Margin: NIWA 26413 (8) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006; NIWA 26414 (7) Stn TAN0616/83, 41.78°S 175.39°E, 1050–1053 m, 13/11/2006; NIWA 32259 (37) Stn SO191-2/149, 41.78°S 175.40°E, 1055 m, 19/02/2007; NIWA 34955 (9) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006.

Description. *Psolidium* species up to 10 mm long, 5.5 mm wide, 5 mm high. Profile moderately low, anal and oral ends commonly raised, no discrete oral or anal valves or plates. Dorsal and lateral scales continuous over body wall, up to 1.5 mm wide, decreasing in size towards the ventral sole. Scales orally and anally smaller, less granular than other scales and paler in colour; dorsal and lateral scales brown, with a 0.25 mm pale grey to white margin; scales on ventral margin up to 0.5 mm wide and lighter in colour, imbricate. Dorsal and lateral tube feet small, inconspicuous, few visible. Tentacles 10, 8 + 2 (ventral smaller). Sole naked midventrally, peripheral series of closely set large tube feet in a single row, sometimes extending

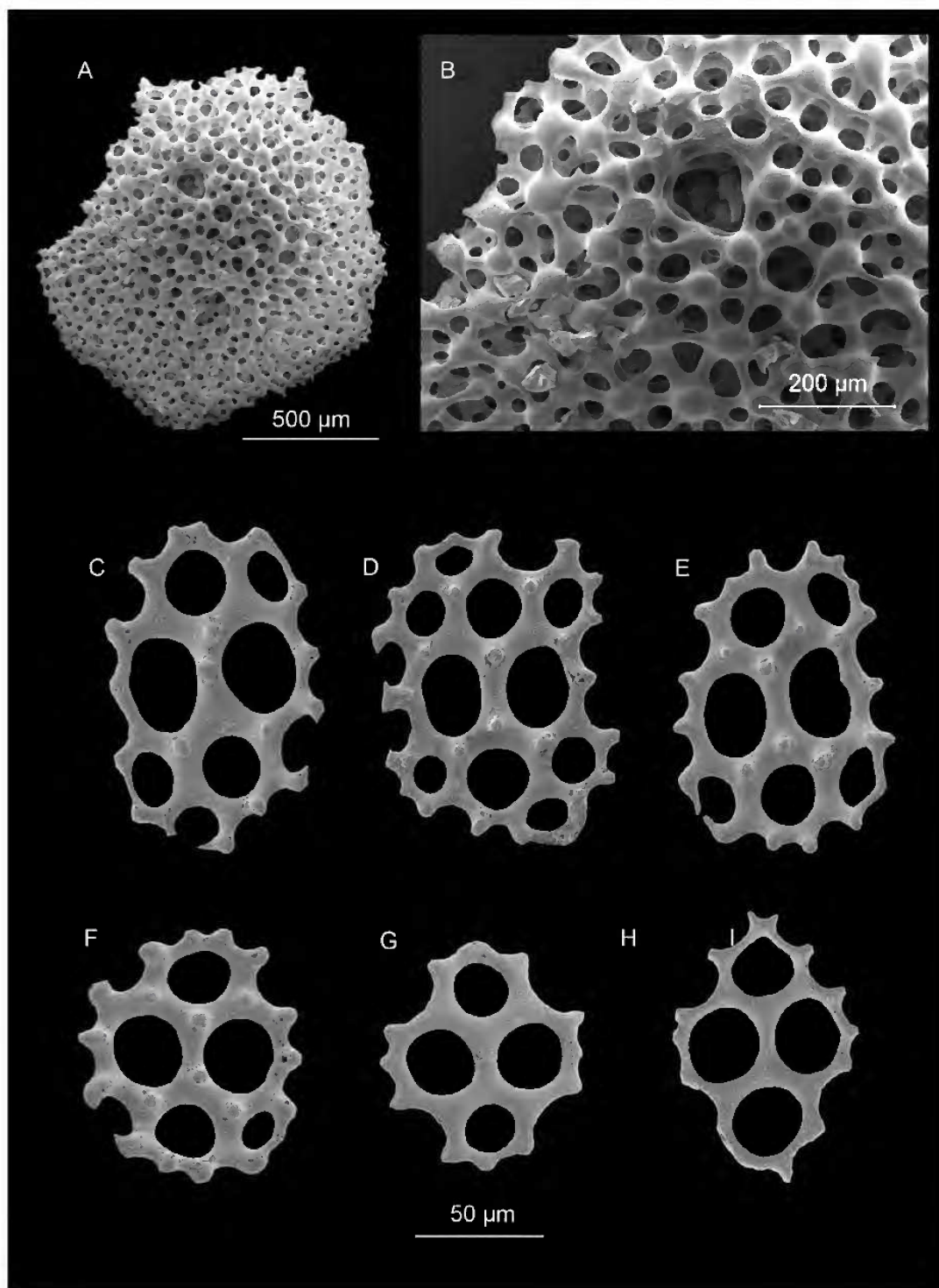


Figure 8. *Psolidium aequum* sp. nov. paratype (A–H, NIWA 32023): A–B, dorsal scales with tube feet holes visible; C–H, ventral ossicles, knobbed plates with 4 uniform central perforations.

onto midventral radius anteriorly and posteriorly; no complete outer series of small peripheral tube feet but on some specimens few smaller tube feet scattered around ventral margin.

Dorsal and lateral ossicles large multilayered perforated plates (scales) with tube feet holes, sometimes with marginal thickening, secondary layering and anastomosing towards outer margins, up to 1580 μm wide with small inconspicuous tube foot canals up to 45 μm wide; large thick, single-layered plates up to 120 μm long with a smooth surface; tube foot support plates thin, rare (due to few dorsal or lateral tube feet) single-layered plates, curved, variably smooth or finely knobbed and relatively curved, up to 80 μm long and with up to 8 perforations. Ventral ossicles flat to slightly curved single-layered perforated plates up to 125 μm long, one side of plates knobbed, other side completely smooth, commonly with 4 perforations (up to 13). Perforations mostly uniform in size but sometimes a few smaller marginal perforations present; margin of plates sharp and angular. Tentacle ossicles long, thick rods, sometimes perforated at either end, less commonly perforated in the middle, rods up to 300 μm long, variable in shape, from straight to curved, rarely with a 'bend' centrally but most commonly with a slight curve, blunt spines sometimes present on either side of centre, sometimes a cluster of perforations at the end of a rod. Smaller single-layered perforated plates, up to 80 μm long, perforations inconsistent in size, shape and arrangement, ranging from flat to curved.

Colour. Preserved: pale to dark brown with grey, light brown or white margins around dorsal and lateral scales. Tentacles brown.

Distribution. New Zealand, Hikurangi Margin, 1040–1059 m.

Etymology. The species name is Latin, meaning equal, to reflect the characteristic regular perforations in the ventral ossicles.

Remarks. *Psolidium aequum* sp. nov. differs from other *Psolidium* species by a combination of the ventral ossicles having predominantly four (sometimes more) uniform perforations, the presence of a few outer ventral peripheral tube feet, the presence of tentacle rod ossicles, commonly with perforations through the middle as well as blunt spines on either side of the middle.

***Psolidium kermadeci* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:883E2AAC-C79C-4145-9656-D41C50DA6A77>

Table 1, Figures 2, 5C–D, 9A–D

Material examined. Holotype. New Zealand, Kermadec Trench: NIWA 72333 (1) Stn TAN0411/32, 35.36°S 178.52°E, 1425–1440 m, 07/03/2011.

Paratype. New Zealand, Kermadec Trench, NIWA 64441 (1) Stn TAN1007/51, 35.42°S 178.62°E, 1380–1545 m, 01/06/2010.

Other material. Kermadec Trench: NIWA 49868 (1) Stn TAN0413/40, 36.96°S 177.29°E, 1652 m, 09/11/2004.

Description. *Psolidium* species up to 10 mm long, 4 mm wide, 3 mm high (preserved). Body form oval, profile dome-like with slightly raised oral and anal cones. Body wall scales

macroscopically evident and continuous over domed dorsal and lateral surface, including oral and anal cones, largest scales up to 575 μm wide and 414 μm high, scale appearance glassy, beady, overall smooth, lacking any bumps or pillars. No discrete oral or anal valves or plates present, scales surrounding oral and anal cones reduced. Conspicuous dorsal tube feet evident, ranging from radial axis presence only through to several tube feet continuous onto interradials. Tentacles 10, 8 + 2 (ventral smaller). Sole distinct, calcareous, peripheral single row of tube feet, no smaller outer row, no midventral tube feet.

Dorsal ossicles are single-layered perforated scales, centrally some anastomosing, with tube feet holes evident, curved perforated support plates up to 55 μm wide. Ventral ossicles are thin-walled perforated plates with tiny blunt knobs, 3–4 perforations predominant, up to 125 μm long, perforations up to 40 μm wide.

Colour. Preserved: white.

Distribution. New Zealand, Kermadec Trench, 1380–1545 m.

Etymology. Named after Huon de Kermadec, an 18th century French navigator after whom the Kermadec islands were named, and eventually the Kermadec Trench, where the specimens were found.

Remarks. This description is based on two small specimens found in relatively close proximity to each other, at similar depths (>1000 m). This is the first record of a *Psolidium* from the Kermadec Trench. *Psolidium kermadeci* sp. nov. is closest to the southern Australian species *Psolidium granuliferum* (Clark, 1938), but differs in possessing conspicuous tube feet dorsal and laterally. Also, like all other Australian *Psolidium* species, *P. granuliferum* is found in shallow depths, whereas *P. kermadeci* is one of the deepest occurring *Psolidium* species in the South Pacific region. This species also differs from the other New Zealand *Psolidium* species described in this paper as the dorsal tube feet are conspicuous and projecting through the body wall scales, whereas the other new *Psolidium* species require microscopic investigations to determine if such tube feet are present. Additionally, the sole ossicles are much thinner, have fewer perforations, and carry spinous knobs marginally.

***Psolidium marriotti* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:EBEB19BA-C15D-448A-86B8-EFBCF894E9FF>

Table 1, Figures 2, 5E–F, 10A–E

Material examined. Holotype. New Zealand, Chatham Rise: NIWA 68137 (1) Stn N857, 43.54°S 179.54°E, 399 m, 17/12/1976.

Paratypes. NIWA 76126 (3) same as holotype.

Other material. New Zealand, Hikurangi Margin: NIWA 76138 (1) Stn E756, 42.02°S 174.44°E, 885 m, 30/03/1967; North Cape: NIWA 55513 (1) Stn TAN0906/83, 34.84°S 173.90°E, 136–138 m, 09/07/2009; NIWA 56813 (1) Stn TAN0906/164, 34.4°S 173.13°E, 145–149 m, 14/07/2009; NIWA 68427 (1) Stn F932, 34.44°S 173.12°E, 113 m, 15/10/1968. Macquarie Ridge, NIWA 40091 (1) Stn TAN0803/63, 52.48°S 160.41°E, 350–560 m, 09/04/2008; NIWA 68413 (2) Stn E228, 54.68°S 158.91°E, 148 m, 24/02/1965; NIWA 76250 (1) Stn C732A, 54.49°S 158.97°E, 220 m, 25/11/1961.

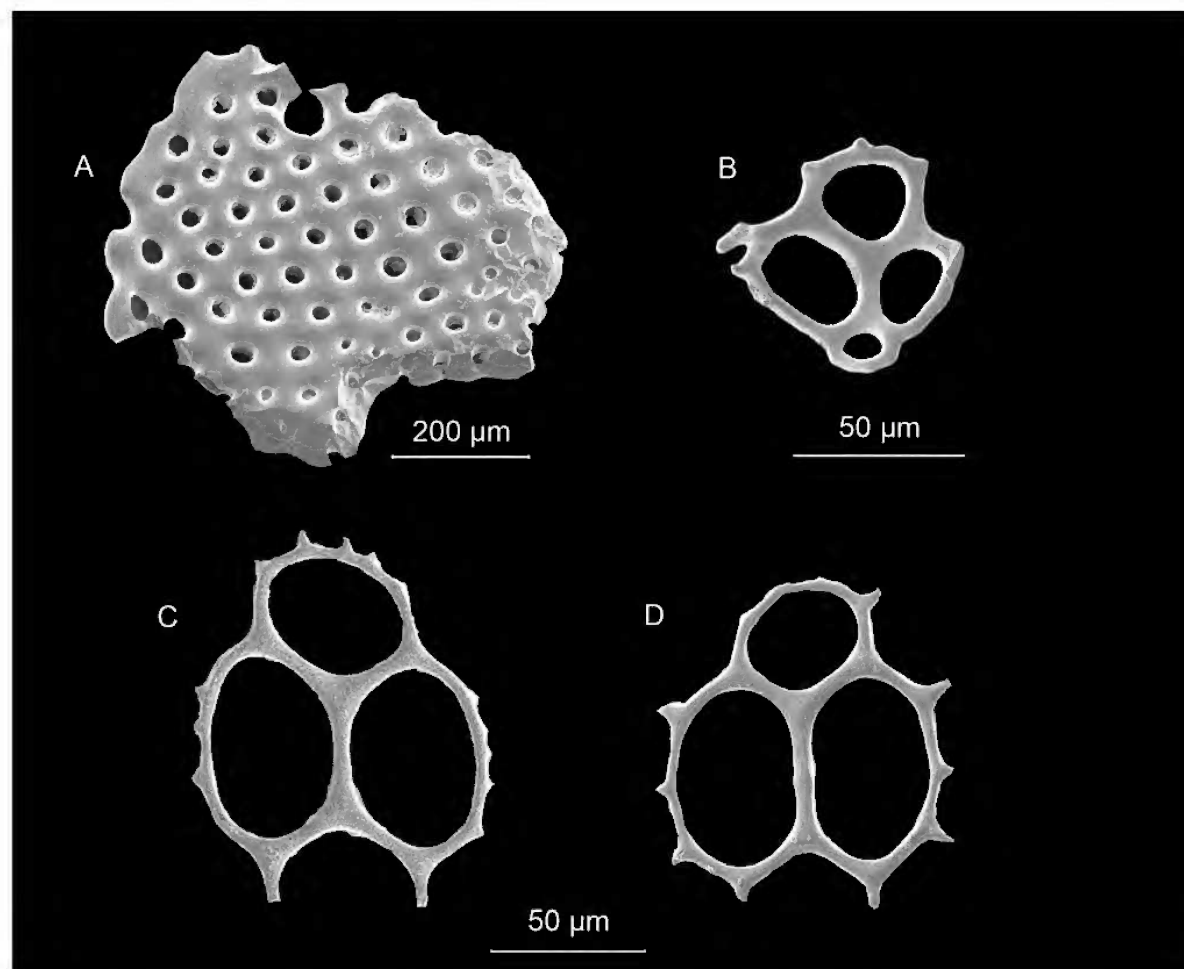


Figure 9. *Psolidium kermadeci* sp. nov. holotype (A–D, NIWA 72333): A, dorsal scale with tube foot perforations; B, dorsal curved support plate; C–D, ventral ossicles, thin-walled perforated plates with spiny knobs on margins.

Description. *Psolidium* species up to 16 mm long, 5 mm high, 8.5 mm wide. Profile moderately high, rarely flat, anal and oral ends commonly raised slightly. No distinct oral or anal valves or plates; these are a continuation of small body wall scales. Dorsal and lateral scales visible and continuous over body wall, up to 3 mm wide but most commonly 1.5–2 mm wide, covered in conspicuous fine granules. Ventral margin scales significantly smaller, reaching a maximum of 0.7 mm wide; two rows surround ventral margin. Dorsal and lateral tube feet can be seen under a microscope on some specimens.

Sole transparent, naked midventrally, peripheral series of large tube feet in 1–2 scattered rows that sit on ventral margin; smaller series of tube feet not present. Tube feet do not consistently extend onto midventral radius, but sometimes up to six tube feet can be clustered on the midventral radius posteriorly and anteriorly; feet a maximum of 0.25 mm apart.

Dorsal and lateral ossicles large multilayered plates (scales) up to 0.2 mm long with tube foot canals up to 40 µm wide, anastomosing, with secondary layering, thickening and/or heavy knobbing present marginally; single-layered plates with thickening, anastomosing and secondary layering also present, with few perforations, up to 190 µm long; tube foot support plates small thin, single-layered perforated plates with up to 18 perforations and up to 80 µm wide, plates curved up at opposing ends, perforations smaller on those upturned edges. Ventral ossicles single-layered perforated plates, surface generally heavily knobbed on one side, smooth on other surface, up to 24 perforations up to 125 µm wide, 2–4 larger central perforations (most commonly 2) with many smaller marginal perforations surrounding them, plate margins have blunt, rounded knobs; tentacle ossicles long rods up to 235 µm long, straight to curved to bent in shape, with

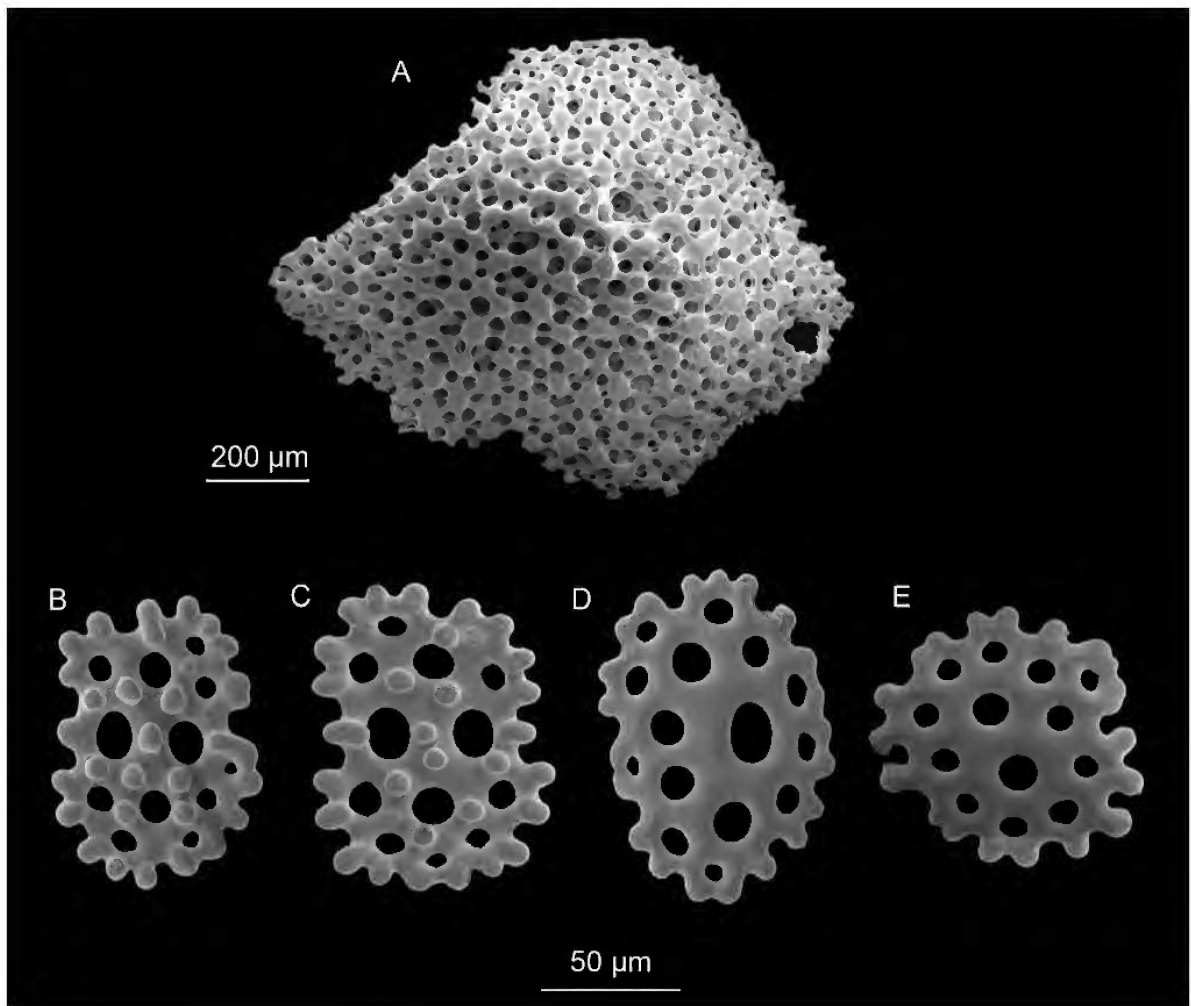


Figure 10. *Psolidium marriotti* sp. nov. (A–E, NIWA 40091): A, dorsal scale with tube foot perforations; B–E, ventral ossicles, knobbed plates with 2 main central perforations and numerous marginal perforations.

perforations at either end but not through the middle; small thin, single-layered plates, variably flat or curved to form a ‘U’ shape, up to 80 µm wide with up to 14 perforations; larger less curved single-layered plates up to 125 µm long with up to 12 thicker, larger perforations.

Colour. Preserved: dark to light brown with a grey to white margin around scales.

Distribution. New Zealand: Hikurangi Margin, Chatham Rise, North Cape; Macquarie Ridge; 136–885 m.

Etymology. Named for Peter Marriott, NIWA, who has provided the macro photos for this paper.

Remarks. *Psolidium marriotti* sp. nov. is similar to *Psolidium*

aequum sp. nov., but is distinguished by the following characters: *P. marriotti* sp. nov. has an abundance of ventral ossicles, rounded and knobbed, with two larger central perforations and many small marginal perforations. In contrast, the ventral ossicles in *P. aequum* are sharper and more angular, with four larger central perforations. The tentacle rods of *P. marriotti* sp. nov. consistently have perforations through the middle and no blunt spines on the edges, whereas those of *P. aequum* sp. nov. only occasionally have perforations and always exhibit blunt edge spines. Additionally *P. marriotti* sp. nov. has no small, outer peripheral ventral tube feet. *P. marriotti* sp. nov. occurs at a shallower depth (135–885 m) than *P. aequum* sp. nov. (1040–1059 m), and it has a much greater geographic range, from New Zealand’s North Cape southward to the Macquarie Ridge.

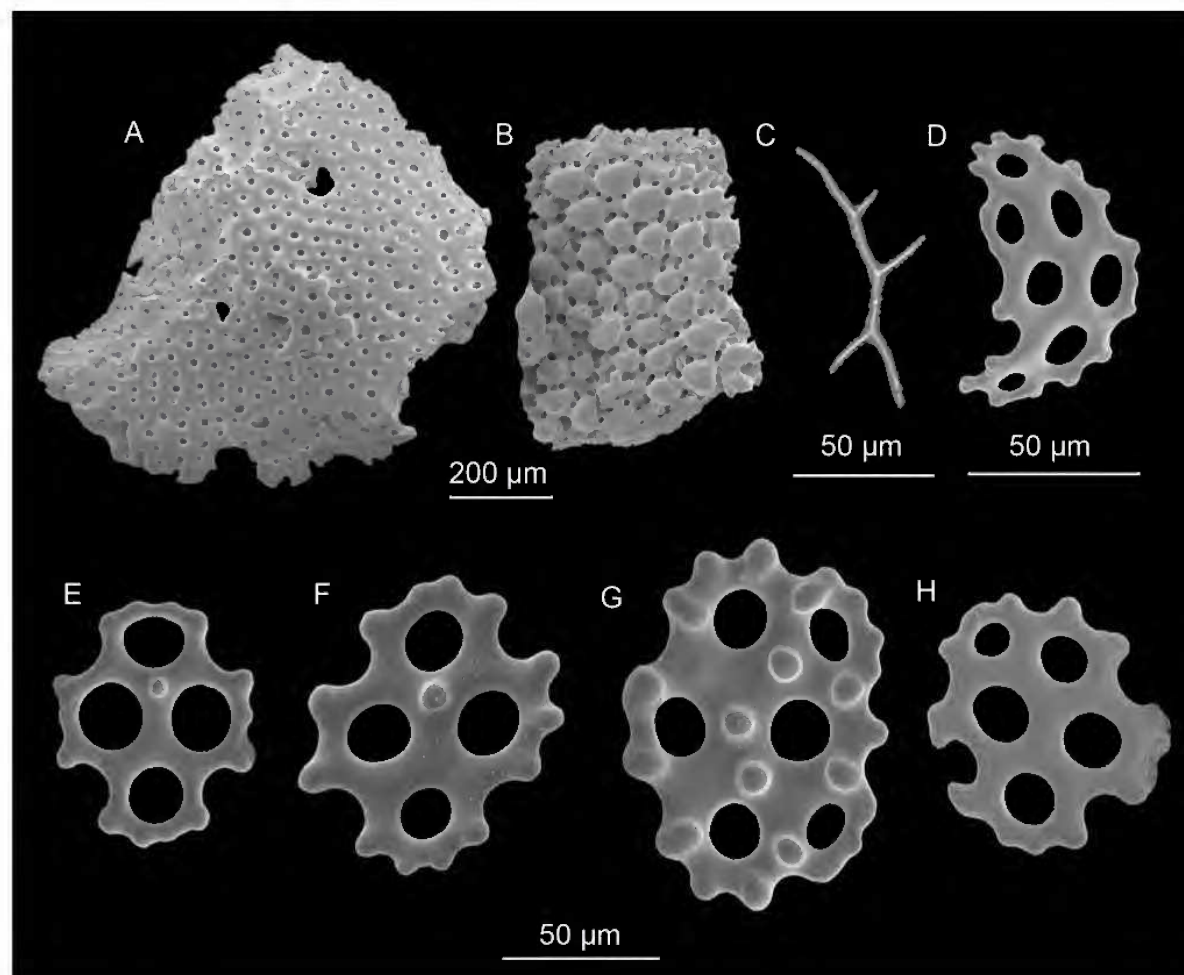


Figure 11. *Psolidium ramum* sp. nov. holotype (A–H, NIWA 73660): A–B, dorsal scales with tube feet perforations visible; C, thorn ossicle from dorsal body wall (also present in ventral body wall); D, curved tube foot support plate from dorsal body wall; E–H, knobbed plates with predominantly 4 even perforations.

***Psolidium ramum* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:A9BB906B-094B-4F5E-83C5-5FFD1C68CC9B>

Table 1, Figures 2, 6A–B, 11A–H.

Material examined. Holotype. New Zealand, North Island west coast canyons: NIWA 73660 (1) Stn TAN1105/88, 36.18°S 173.68°E, 188–210 m, 01/04/2011.

Description. *Psolidium* species up to 16 mm long, 8 mm wide, 2 mm high. Profile low, body form oval. Oral cone slightly higher than anal cone; no distinct oral or anal valves or plates, approximately 230 µm wide, macroscopically smooth, microscopically glassy and beady texture, lacking significant bumps or pillars. Body wall dorsal and lateral scales macroscopically evident and continuous over body wall, up to

2.3 mm at widest point. Tube feet numerous, up to 10 per scale, evident throughout dorsal and lateral scales. Tentacles 10; 8 + 2 (ventral smaller). Sole largely destroyed, with peripheral single row of larger tube feet and smaller outer non-continuous ring of tube feet; midventral row of tube feet present, only 2 feet found as a result of a damaged sole.

Dorsal and lateral ossicles include large multilayered thick scales with small perforations and conspicuous round tube feet holes up to 60 µm in diameter; numerous tube feet support plates up to 85 µm wide; rare single-layered plates with 4–9 perforations up to 70 µm wide; broken thorn (branching rod) ossicles present.

Ventral ossicles knobbed perforated plates up to 100 µm wide with blunt marginal projections, predominantly 4 projections, sometimes more projections peripherally, and thick elongate plates up to 160 µm long, without knobs, with

small perforations; small crosses up to 60 μm wide; thorn ossicles present, mainly broken, largest 135 μm .

Colour. Preserved: white, with dorsal and lateral scales, grey centrally.

Distribution. New Zealand, North Island west coast, 188–210 m.

Etymology. The Latin word 'ramum' = branching, in reference to the branch-like thorn ossicles in the dorsal and ventral body wall of this species.

Remarks. This description is based on one specimen, of which the ventral sole was partially destroyed. The distinctive thorn ossicles, while rare, were present in both the dorsal and ventral body wall and have not been reported for any other New Zealand *Psolidium* species. In *Psolidium ramum* sp. nov. the ventral ossicles have predominantly 4 perforations; in *P. marriotti* sp. nov. they are numerous. *P. aequum* sp. nov. has larger perforations, thicker ossicles and many more angular knobs on ossicle margins. The thickened elongated plates are unique to *P. ramum* sp. nov. The northwest Australian species *P. parmatum* (Sluiter, 1901) and *P. nigrescens* Clark, 1938 also contain thorn ossicles similar to those of *P. ramum* sp. nov., but *P. parmatum* has bulbous pillars on the dorsal and lateral scales, and *P. nigrescens* is black, and has cups and crosses ventrally.

Further specimens would contribute to this description. The structure and distribution of ventral tube feet are difficult to determine, and there was little material available for ossicle extraction and SEM study. The tentacle ossicles could not be described due to the damaged state of the specimen, and these will need to be examined in the future.

Psolidium whittakeri O'Loughlin and Ahearn, 2008

Psolidium incertum.—Ludwig and Heding, 1935: 162–164, text-figs 28–29 (non-*Psolidium incertum* (Théel, 1886) = *P. poriferum* (Studer, 1876) (above).

Psolidium whittakeri.—O'Loughlin and Ahearn, 2008: 38, figs 3b–d, 8d–f.

Material examined. New Zealand, Hikurangi Margin: NIWA 63907 (1) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010; NIWA 63914 (1) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010. Kermadec Trench: NIWA 49868 (1) Stn TAN0413/40, 36.96°S 177.29°E, 1652–1669 m, 09/11/2004; NIWA 72086 (1) Stn TAN1105/27, 34.27°S 172.78°E, 66–67 m, 27/03/2011. Southern Plateau: NIWA 76139 (1) Stn E824, 46.97°S 166.54°E, 1217 m, 24/10/1967.

Description. O'Loughlin and Ahearn (2008) provide a recent and comprehensive description of this species. The material examined here concurs with this description.

Distribution. Antarctica, South Sandwich Island, South Shetland Island, Bouvet Island, 146–759 m; New Zealand, Hikurangi Margin, Kermadec Trench, Southern Plateau, 66–1669 m (this paper).

Remarks. *Psolidium whittakeri* O'Loughlin and Ahearn, 2008 is so far only known from the Southern Ocean around Antarctica. This current material has extended the range of this species around the Antarctic continent, as well as northwards into Subantarctic and temperate latitudes. Additionally, the reported depth range has been extended from 759 m to 1669 m at the more northern record (NIWA 49868).

Acknowledgements

We are grateful for the assistance of the following people: Kareen Schnabel and Sadie Mills, (NIWA, providing specimens from the NIC); Matthew Brown (Waikato University, registering the material); Peter Marriot (NIWA, macro specimen photos); Carina Sim-Smith (NIWA, SEM images); Michelle Kelly (NIWA, project manager); Kareen Schnabel (NIWA, internal review); Mark O'Loughlin (MV, specimen identification and literature advice); and Sue Hallas (Nelson, NZ) (translating type material descriptions). Thanks are also due to the journal's two reviewers who provided numerous helpful comments.

Specimens were collected on the following voyages: (i) RENEWZ I – NEW ZEEPS voyage, the first component of the project 'Exploration of Chemosynthetic Habitats of the New Zealand Region', funded by NOAA Ocean Exploration and NIWA, with cofunding from Woods Hole Oceanographic Institution, Scripps Oceanographic Institution and the University of Hawaii; (ii) the New Zealand Cold Vents: New Vents program (RV *Sonne* voyage SO191) conducted by IFM-GEOMAR Leibniz-Institut für Meereswissenschaften an der Universität Kiel and partners; (iii) the interdisciplinary New Zealand–Australian 'MacRidge 2' research voyage (TAN0803), the biological component of which was part of NIWA's research project 'Seamounts: their Importance to Fisheries and Marine Ecosystems' funded by the former New Zealand Foundation for Research, Science and Technology (FRST) and CSIRO's Division of Marine and Atmospheric Research project 'Biodiversity Voyages of Discovery' funded by the CSIRO 'Wealth from Oceans Flagship'; (iv) the Ocean Survey 20/20 Bay of Islands Coastal Biodiversity, Sediment and Seabed Habitat Project, funded by Land Information New Zealand (LINZ); (v) Biogenic Habitats on the Continental Shelf Project (voyages TAN1105 and TAN1108), funded by the New Zealand Ministry of Fisheries (now MPI) (Biogenic Habitats: ZBD200801), the former New Zealand FRST (CCM: COIX0907) and the NIWA Capability Fund (CF111358); (vi) Oceans Survey 20/20 RV *Tangaroa* days funded by LINZ; (vii) Kermadec Arc Minerals (KARMA) voyage, funded by the former FRST, in collaboration with Auckland University, GNS Science (New Zealand), and Woods Hole Oceanographic Institute (USA); (viii) specimens collected on fisheries trawl surveys (TAN0201, project code HOK200102; TAN0301, project code HOK200202; TAN0601, project code: KOK200502; TAN0701, project code: HOK200602; TAN0801, project code: HOK200702) were funded by MPI; (ix) voyage by NIWA as part of the 'Impact of Resource Use on Vulnerable Deep-sea Communities' project (COIX0906) funded by the New Zealand Ministry of Business, Innovation and Employment (MBIE); (x) Seamounts: their Importance to Fisheries and Marine Ecosystems, undertaken by the NIWA and funded by the New Zealand Foundation for Research, Science and Technology with additional funding from MPI; (xi) Ocean Survey 20/20 Chatham/Challenger Biodiversity and Seabed Habitat Project, jointly funded by the MPI, LINZ, NIWA and the Department of Conservation; (xii) the New Zealand Oceanographic Institute; and (xiii) the Scientific Observer Program funded by MPI.

This research was primarily funded by NIWA Core funding from the Ministry of Business, Innovation and Employment through an internal Science Award under project SA124076, which supported Emily Whitfield's visit to New Zealand. Some additional funding was provided by NIWA under the Coasts and Oceans Research Programme 2 (2012/13 SCI).

References

- Bronn, H.G. 1860. *Die klassen und ordnungen des thier-reichs, wissenschaftlich dargestellt in wort und bild. 2. Aktinozoen*. C.F. Winter'sche Verlagshandlung: Leipzig and Heidelberg. 434 pp., 49 pls.
- Burmeister, H. 1837. *Handbuch der Naturgeschichte. Zweite Abteilung, Zoologie*. Pp. 369–858. Verlag von Theod. Chr. Friedr. Gnelin: Berlin.
- Clark, H.L. 1901. The Holothurians of the Pacific Coast of North America. *Zoologischer Anzeiger* 24: 162–171.
- Clark, H.L. 1938. Echinoderms from Australia. An account of collections made in 1929 and 1932. *Memoirs of the Museum of Comparative Zoology at Harvard College* 55: 1–596, 28 pls, 63 figs.
- Dawbin, W.H. 1950. A guide to the holothurians of New Zealand. *Tuatara* 3(1): 33–41, pls 1–2.
- Deichmann, E. 1941. The Holothuroidea collected by the “Velero III” during the years 1932–1938. Part I. Dendrochirotida. *Allan Hancock Pacific Expeditions* 8(3): 61–195.
- Düben, M.W., and Koren, J. 1846. Översigt af Skandinaviens Echinodermter [Overview of Scandinavian Echinodermata]. *Kungliga Svenska Vetenskapsakademiens Handlingar* 1844: 229–328, pls VI–XI.
- Ekman, S. 1923. Über *Psolus squamatus* und verwandte Arten. Zugleich ein Beitrag zur Bipolaritätsfrage. *Arkiv för Zoölogie* 15: 1–59.
- Ekman, S. 1925. Holothurien. *Further zoological results of the Swedish Antarctic Expedition 1901–1903* 1(6): 1–194.
- Gistel, J. 1848. Echinodermata. Class 11. Pp. 174–77 in: *Naturgeschichte des Tierreichs für höhere Schulen*. Hoffmann: Stuttgart. xvi + 216 pp., 32 pls.
- Grube, A.E. 1840. *Aktinien, Echinodermen und Würmer des Adriatischen und Mittelmeeres*. J.H. Bon: Königsberg. Pp. 33–43, 1 pl.
- Gutt, J. 1990. New Antarctic holothurians (Echinodermata) – I. Five new species with four new genera of the order Dendrochirotida. *Zoologica Scripta* 19(1): 101–117.
- Koren, J. 1845. Beskrivelse over *Thyone fusus* og *Cuviera squamata*. *Nyt Magazin for Naturvidenskaberne* 4: 203–225.
- Ludwig, H. 1886. Die von G. Chierchia auf der Fahrt der Kgl. Italienische Corvette *Vettor Pisani* gesammelten Holothurien. *Zoologische Jahrbücher* 2: 1–36, 2 pls.
- Ludwig, H. 1894. Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U.S. Fish Commission steamer *Albatross*, during 1891. XII. The Holothuroidea. *Memoirs of the Museum of Comparative Zoology, Harvard College* 17(3): 1–183, pls 1–19.
- Ludwig, H., and Heding, S.G. 1935. Die Holothurien der Deutschen Tiefsee-Expedition. I. Fusslose und dendrochirote Formen. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer Valdivia 1898–1899* 24(2): 123–214.
- Mackenzie, M., and Whitfield, E. 2011. An overview of the Australian psolid sea cucumbers (Echinodermata: Holothuroidea: Psolidae) with the description of 5 new species. *Zootaxa* 3037: 21–36.
- Mah, C.L., McKnight, D.G., Eagle, M.K., Pawson, D.L., Ameziane, N., Vance, D.J., Baker, A.N., Clark, H.E.S., and Davey, N. 2009. Phylum Echinodermata: sea stars, brittle stars, sea urchins, sea cucumbers, sea lilies. Pp. 371–400 in: Gordon, D.P. (ed.), *New Zealand Inventory of Biodiversity. Volume 1. Kingdom Animalia: Radiata, Lophotrochozoa, Deuterostomia*. Canterbury University Press: Christchurch.
- Massin, C., and Hendrickx, M.E. 2011. Deep-water Holothuroidea (Echinodermata) collected during the TALUD cruises off the Pacific coast of Mexico, with the description of two new species. *Revista Mexicana de Biodiversidad* 82: 413–443.
- Mortensen, T. 1925. Echinoderms of New Zealand and the Auckland–Campbell Islands. 4. Holothuroidea. Pp. 322–86 in: *Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916. No. 29. Videnskabelige Meddelelser Dansk Naturhistorisk Forening, København*, 79.
- Müller, O.F. 1776. *Zoologica Danicae Prodomus, seu animalium Danicae et Norvegiae indigenarum characteres, nomine, et synonyma imprimis popularium*. Havniae: Copenhagen. 274 pp.
- Oken, L. 1815. *Lehrbuch der Naturgeschichte. Part 3. Zoologie* xxxviii, 850, xviii. Jena.
- O'Loughlin, P.M., and Ahearn, C. 2008. Antarctic and Sub-Antarctic species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 23–42.
- O'Loughlin, P.M., and Maric, D. 2008. Australian species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 1–22.
- O'Loughlin, P.M., and Whitfield, E. 2010. New species of *Psolus* Oken from Antarctica (Echinodermata: Holothuroidea: Psolidae). *Zootaxa* 2528: 61–68.
- Pawson, D.L. 1969. Holothuroidea. Pp. 36–38, 1 pl. in: Bushnell, V.C. and Hedgpeth, J.W. (eds), *Distribution of selected groups of marine invertebrates in waters south of 35°S latitude. Antarctic Map Folio Series (II)*. American Geographical Society: New York.
- Pawson, D.L. 1970. The marine fauna of New Zealand: Sea cucumbers (Echinodermata: Holothuroidea). *Bulletin New Zealand Department of Scientific and Industrial Research* 201: 7–65, 10 pls.
- Pawson, D.L. 1971. *Ekkentropelma brychia* n.g., n.sp., an Antarctic psolid holothurian with a functionally lateral sole. *Proceedings of the Biological Society of Washington* 84(14): 113–118.
- Pawson, D.L., and Fell, H.B. 1965. A revised classification of the dendrochirote holothurians. *Breviora*, 214: 1–7.
- Perrier, R. 1905. Holothuries antarctiques du Muséum d'Histoire Naturelle de Paris. *Annales des Sciences Naturelles. Zoologie* 1: 1–146, 5 pls.
- Philippi, A. 1857. Vier neue Echinodermen des Chilenschen Meeres. *Archiv Naturgeschichte* 23: 130–134.
- Sluiter, C.P. 1901. Die Holothurien der Siboga-Expedition. *Siboga-Expédition* 44: 1–142, 10 pls. Buchhandlung und Druckerei vormals E.J. Brill: Leiden.
- Studer, T. 1876. Über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln, gesammelt auf der Reise SMS *Gazelle* um die Erde. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften*. Berlin. Pp. 452–465.
- Théel, H. 1886. Report on the Holothuroidea dredged by H.M.S. *Challenger* during the years 1873–76. Part II. *Report on the Scientific Results of the Voyage of H.M.S. Challenger During the Years 1873–76. Zoology* 14(39): 1–290, 16 pls.
- Vaney, C. 1906. Holothuries. *Expédition Antarctique Française (1903–1905). Sciences Naturelles: Documents Scientifiques*. Masson et Cie, Éditeurs: Paris. 30 pp., 2 pls, 1 map.
- Verrill, A.E. 1867. Notes on the echinoderms of Panama and the west coast of America, with descriptions of new genera and species. *Transactions of the Connecticut Academy of Arts and Sciences* 1(2): 251–322.